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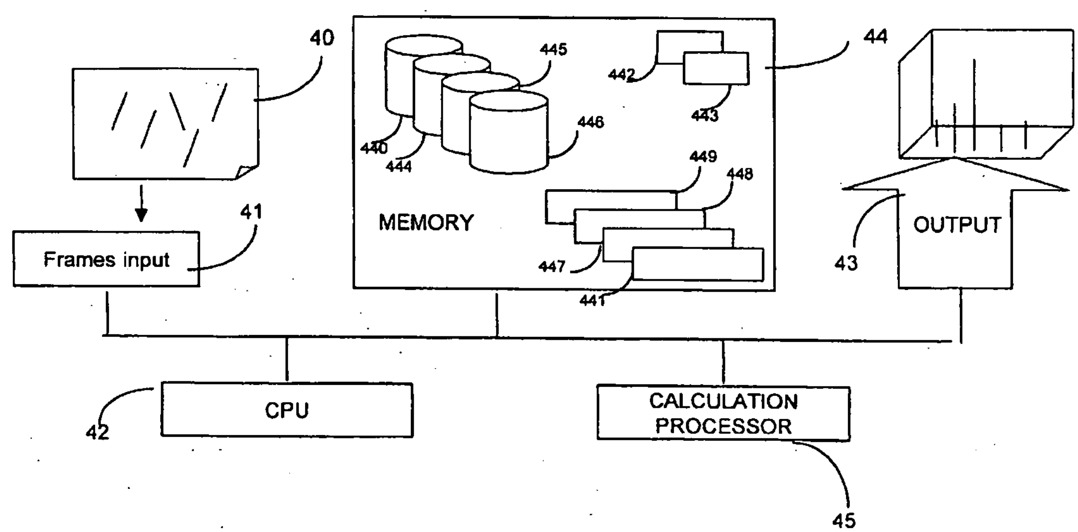
(54) Title: ANALYSING A MOVING IMAGE



(57) Abstract: In a moving picture, pixel values are a function of both space and time. A measure of visual significance is generated by taking the pixel along with a second, nearby, randomly chosen pixel (though its temporal offset from the first may be fixed) and comparing these with a comparison pixel pair. The comparison pair are randomly selected from the image (though its temporal offset may be fixed) but the spacial and temporal displacement between the members of the comparison pair is the same as between the numbers of the test pair. Further comparison pairs are then chosen, and the measure generated depends on the number of matches obtained in the comparisons. A third pair may also added. Also, the pairs may be replaced by groups of more than two.

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Analysing a Moving Image

This invention relates to a system for locating salient objects or features contained within a moving image.

Existing systems for gauging visual attention extract previously specified features (e.g. colour, intensity, orientation) from images, and then train classifiers (e.g. neural networks) to identify areas of high attention. These trainable models rely heavily on the selection of the features to be searched for in the image, and have no way of handling new visual material that has little similarity with that used to design and test the system. Paradoxically, a feature may simply be too anomalous to be identified as such by a trained system. Such systems also require considerable computational resource in order to process the pre-selected features and moreover this burden increases without limit as the scope of the procedure is extended and more features are added.

According to one aspect of the present invention there is provided a method of processing a moving image, for identifying areas of visual attention, comprising:

storing successive pictures of the moving image as respective arrays of picture element values;

defining a test group of picture elements comprising a first test picture element and a second test picture element having a spatial offset and a temporal offset from the first;

defining a comparison group of picture elements comprising a first comparison picture element having a spatial and temporal offset from the first test picture element and a second comparison picture element having a spatial and temporal offset from the first comparison picture element equal respectively to the spatial and temporal offset of the second test picture element from the first test picture element;

comparing the picture element values of the first and second test picture elements with the picture element values of the first and second comparison picture elements respectively, in accordance with a predetermined match criterion;

defining further such comparison groups and comparing the test pictures element with those of the further comparison groups;

generating a visual attention measure for the first test picture element in dependent on the number of comparisons made for it which the comparison results in a mismatch.

The invention may be used to identify the principal subject in a visual scene, by identification of the region containing pixels having the greatest anomaly values. It may be used to determine a measure of visual attention afforded to a given object in a visual scene by comparison of the anomaly values generated for the pixels representing that object with the anomaly values generated for other parts of the scene.

The repetitive nature of the process lends itself to parallel processing, and it should be understood that several test pixels may be processed in parallel with each other, and for each test pixel, several groups of neighbour pixels may also be processed in parallel.

In order to allow for minor variations in intensity between otherwise similar elements of a scene, the comparison of values preferably allows a small difference in values between two pixels to be considered a match, and the term "substantially similar" used above should be understood in that context. The value of this threshold difference may be varied for different cycles, those values which produce a suitable distinction between elements being stored and re-used on subsequent cycles of the process.

For a colour image the intensity values may be three-element (red, green, blue) vectors. Alternatively other colour spaces such as hue, saturation, luminance etc. may be used.

In another aspect, the invention provides a method of processing a sequence of visual images, for identifying areas of visual attention, comprising the steps of:

storing a sequence of images as a multi dimensional array of pixels, each pixel having a value;

selecting test pixels from the array,

for each test pixel, selecting one or more neighbour groups of pixels neighbouring the test pixel;

selecting comparison pixels from the array;

identifying a group of pixels neighbouring a selected comparison pixel having the same respective positional relationships to the comparison pixel as a selected neighbour group of pixels has to the test pixel;

comparing the values of the selected neighbour group with the values of the identified group in accordance with a predetermined match criterion,

generating a measure of visual attention for each test pixel, in dependence upon the number of comparisons made for that test pixel for which the comparison results in a mismatch.

This invention identifies saliency in visual scenes by measuring the difficulty in finding similarities between neighbourhoods in the scene. Pixels in an area that is similar to much of the rest of the scene therefore score low measures of visual attention, so are not considered to be worthy of attention. On the other hand a region that possesses many dissimilarities with other parts of the image will attract a high measure of visual attention, as the anomaly values scored will be large.

The invention makes use of a trial and error process to find dissimilarities between parts of the image and does not require prior knowledge of the nature of the anomalies to determine saliency. The method avoids the use of processing dependencies between pixels and is capable of a straightforward parallel implementation for each pixel.

A preferred embodiment will now be described, by way of example, with reference to the figures, in which

Figure 1 illustrates schematically the basic components of a general purpose computer capable of performing the invention;

Figure 2 is a flowchart illustrating the analysis of a still picture.

Figure 3 represents a still picture to be processed by the method of Figure 1;

Figure 4 is a flowchart illustrating the operation of an embodiment of the invention;

Figure 5 illustrates the processing of consecutive frames of the moving picture; and

Figure 6 shows example selection of test pixel groups in order to increase processing speed.

The components illustrated in Figure 1 comprise an input means 41, comprising a video input and a frame capture device (of conventional construction) for storing several consecutive frames of an image in a store 440. In the examples given below, the store 440 would need to contain three, or four, consecutive frames. Figure 1 also shows a central processing unit (CPU) 42, an output unit such as a visual display unit (VDU) or printer 43, a memory 44, and a calculation processor 45. The memory includes stores 440, 444 – 446, registers 441, 447 - 449 and counters 442, 443. The data and the programs for controlling the computer are stored in the memory 44. The CPU 42 controls the functioning of the computer using this information.

By way of introduction, we firstly describe a method analysing a still picture (a single frame), though it is to be understood that the present invention does not extend to this method, which is described and claimed in our co-pending international patent application no. PCT/GB01/00504.

Considering now Figures 1 and 2, an image 40 to be analysed is accessed by the input means 41 and stored in a digital form in an image store 440, as an array A of pixels x where each pixel has colour intensities (r_x, g_x, b_x) attributed to it.

A pixel x_0 is then selected from the array A (step 1), and its intensity value (r_x, g_x, b_x) is stored in a test pixel register 441.

An anomaly count c_x, stored in an anomaly counter 442, and a count of the number of pixel comparisons I_x (stored in a comparison counter 443) are both set to zero (step 2).

The next step is the random selection of a number of points in the vicinity of the test pixel x_0. This region is defined by a distance measure u_x (typically in units of pixels). Thus, n pixels x_j are selected such that

$$\mathrm{dist}(x_j - x_{j-1}) < u_x$$

where $j = 1, ..., n$ and $x_0 = x$.

The distance used may be any of those conventionally used, such as the Euclidean distance or the "city block distance between the positions within the image of the two pixels. If the horizontal and vertical coordinates of x_j are $p(x_j)$ and $q(x_j)$ then the Euclidean distance is

$$\sqrt{[p(x_j) - p(x_{j-1})]^2 + [r(x_j) - r(x_{j-1})]^2}$$

whilst the city block distance is

$$|p(x_j) - p(x_{j-1})| + |r(x_j) - r(x_{j-1})|$$

Typically n = 3 , and $u_x = 1$. An example of such a group is shown in Figure 3, in which the test pixel, (shown boxed) has pixels (shown shaded) associated with it. For $u_x = 1$, the pixels are contiguous, but, in general the pixels may not necessarily neighbour one another or be contiguous in any sense. The definition of the neighbour pixels is stored in the neighbour group definition store 444.

A pixel y_0 is now selected randomly (step 6) from the array A to be the current comparison pixel (also shown boxed in Figure 3) whose identity is stored in a comparison pixel register 447.

The value of I_x stored in the comparison counter 443 is incremented (step 7): if a limit L is exceeded, no further comparisons for the test pixel x are made (step 8). The contents of the neighbour group definition register 444 are then used by the calculation processor 45 to define a set of pixels forming a test group x_j (register 448) and a set of pixels forming a comparison group y_j (register 449), each pixel y_j of the comparison group having the same positional relationship to the comparison pixel y as the corresponding pixel x_j in the test group has to the test pixel x (step 9).

The calculation processor 45 then compares each of the pixels x_j (shaded in Figure 3) with the corresponding pixel y_j (also shown shaded), using a set of threshold values Δr_x, Δg_x and Δb_x.

A pixel y is identified as being similar to a test pixel x if :

$|r_y - r_x| < \Delta r_x$ and

$|g_y - g_x| < \Delta g_x$ and

$|b_y - b_x| < \Delta b_x$.

- where Δr_x, Δg_x and Δb_x are threshold values which are, in this embodiment, fixed.

If all the pixels x_j in the test group are similar to their corresponding pixels y_j in the comparison group, the process is repeated by selecting a new set of neighbouring pixels (step 5) and a new comparison pixel y_0 (step 6). If (as illustrated in Figure 3) one or more pixels x_j in the test group are not similar to the corresponding pixel y_j in the comparison group, in accordance with the similarity definition above, the count c_x stored in the anomaly count register 442 is incremented (step 10). Another comparison pixel y_0 is randomly selected and stored in the comparison pixel register 447 (return to step 6) and the neighbour group definition retrieved from the neighbour group definition store 444 is used to supply a new comparison neighbour group to the comparison group register 449 for comparison with the test group stored in the test group register 448. A set of pixels x_j is retained in the test group register 448 so long as it continues to fail to match other parts of the image. Such a set represents a distinguishing feature of the locality of x - the more failures to match that occur, the more distinctive it is. The more comparison pixels y that the test pixel x fails to provide matches for, the higher the anomaly value c_x stored in the anomaly counter 442 becomes. Conversely, the more matches that the test pixel x generates, the lower the value of the anomaly value when the threshold L is reached by the comparison counter 443. As L comparisons are made each time, the anomaly value c_x which results from the process may be considered to be a measure of the proportion of randomly selected pixels which would fail to provide a match for the test pixel x.

When the iteration value I_x stored in the comparison counter 443 reaches the threshold value L, the iterative process stops (step 8) and the current anomaly value c_x stored in the anomaly counter 442 is output at the output unit 43 as the anomaly value for the pixel x. This final anomaly value c_x is the measure of visual attention for the test pixel x, and is the number of attempts (from a total of L attempts) for which the inherent characteristics (i.e. the colours) of randomly selected neighbours of pixel x failed to match the corresponding neighbours of randomly selected pixels y. A high value for c_x

indicates a high degree of mismatch for pixel x with the rest of the image and consequently that pixel x is part of an object worthy of visual attention.

In this embodiment, the process is repeated, from step 1, for every pixel in the image as the test pixel, so that a value c_x is obtained for every pixel x in the array A. Typically, L may be set to be 100.

As described above, comparisons are performed for the neighbouring pixels x_j, y_j, j=i,...n; however, if desired, the original or root pixels may also be included, the comparisons being performed for j = 0, ...,n.

The output unit 43 is typically a storage medium which stores the anomaly values of each pixel for display by means of a printer, visual display unit, etc. or for subsequent processing.

We now turn to the description of an embodiment of the present invention in which the aim is to analyse a moving picture where pixel values are a function of horizontal and vertical position, and time.

Suppose that each pixel value $\underline{a}$ is a function of p, q and t, i.e. the horizontal and vertical position within the picture, and time expressed as a number of frames. As before, we wish to compare a test group of pixels $\underline{x} = (x_0, x_1, x_2, \ldots x_n)$ where x_j has spatial coordinates p_j, q_j and time t_j with randomly selected comparison groups such as $\underline{y} = (y_0, y_1, y_2 \ldots y_n)$ (where y_k is p_k, q_k, t_k). x_1, x_2 etc. are chosen to lie within some distance in p, q, t space of a starting pixel x_0. y_1, y_2 etc. have in this space the same positions relative to y_0; that is:

$$p(x_j) - p(x_0) = p(y_j) - p(y_0)$$

$$q(x_j) - q(x_0) = q(y_j) - q(y_0)$$

$$t(x_j) - t(x_0) = t(y_j) - t(y_0)$$

As before, the spatial displacements of x_j from x_0 (or x_{j-1}) are selected at random subject to a limit u_x. The temporal displacements could also be selected at random within a time limit τ, or if desired could be zero, so that x_j are all from the same frame, but we prefer to avoid selecting a test group (or comparison group) entirely from one frame, and

therefore we apply an additional constraint that at least one pixel is selected from a different frame from the one in which the "root" pixel x_0 (or y_0) lies. Thus, in this example, we choose n = 1 and require that $t(x_1) - t(x_0) \equiv t(y_1\text{-}y_0) \equiv 1$ that is, every group of pixels consists of a pixel from one frame t and a pixel from the following frame. Further, we prefer that the comparison pixel y_0 is always chosen from a different frame from the one in which x_0 lies: in this example we require that $t(y_0) = t(x_0) = t(x_0)+1$ so that the comparison group is one frame later in time than the test group.

The procedure used is shown in Figure 4:

Step 101. Test pixel x_0 : (p, q, t) = (1, 1, T-1).

Step 102. Set c_x and I_x to zero.

Step 105. Choose at random a pixel $x_1 = (p+\Delta p, q+\Delta q, T)$, with $\Delta p \le u_x$, $\Delta q \le u_x$.

Step 106. Choose pixel $y_0 = (p', q', T)$ where p', q' are selected at random from the array; Define pixel $y_1 = (p'+\Delta p, q'+\Delta q, T+1)$

Step 107. Increment I_x. If the number of comparisons $I_x > L$, c_x contains the score for x: choose a new pixel x_1 and go to step 102.

Step 109. Test for a match between x and y – i.e.

if $|r(x_0) - r(y_0)| \le \Delta r$

and $|g(x_0) - g(y_0)| \le \Delta g$

and $|b(x_0) - g(y_0)| \le \Delta g$

and $|r(x_1) - r(y_1)| \le \Delta r$

and $|g(x_1) - g(y_1)| \le \Delta g$

and $|b(x_1) - b(y_1)| \le \Delta b$

a match has been found.

If a match is found, go to step 105.

Step 110. If no match is found, increment c_x and go to step 106.

Whilst the above gives satisfactory results, it can be improved by choosing a third pixel group consisting of pixel z_0 in frame T-2 having the same absolute position as y_0 and choosing pixel z_l in frame T-1 having the same absolute spatial position as y_l. The procedure is substantially the same, the criterion for a match being that x matches both y and z. For the purposes of illustration, Figure 5 shows four frames T-2, T-1, T and T+1, with a pixel x_0 in frame T-1 and its neighbour x_1 in frame T with a spatial offset (1,-1), whilst pixels y_0 in frame T and z_0 in frame T-2 have the same spatial position as each other. Their neighbours y_1, z_1 (in frames T+1 and T-1) have the same spatial offset (1,-1) from y_0 or z_0, respectively, as x_1 has from x_0. The 3x3 boxes in the Figure simply serve to mark the same positions in consecutive frames.

Some modifications will now be discussed:

1. The thresholds used in an embodiment of the invention for colour images will depend upon the colour space in which the comparison between pixels is carried out. In another embodiment of the invention operating on colour images in the hue, saturation, value (HSV) space Δh_x, Δs_x, Δv_x colour difference thresholds can be used. Here, pixel values consist of h_x, s_x and v_x and the calculation is carried out in the HSV colour space pixel y is identified as being similar to test pixel x is:

$$|v_y - v_x| < \Delta v_x, \text{ and } |s_y - s_x| < \Delta s_x, \text{ and } |h_y - h_x| < \Delta h_x$$

where $\Delta h_x = Z*(2- v_x)*(2- s_x)$. Z is stored in an empirical table of thresholds dependent upon h_x. This results in a larger value of Δh_x for low values of v_x and s_x.

Alternatively, for a grey-scale image, single luminance values t_x and a luminance difference threshold Δt_x would be used.

2. The selection of a group of n pixels x_j in the neighbourhood of the test pixel x from the image store 440 may be made such that:

$$\mathrm{dist}(x_j, x_{(j-1)}) < u_x$$

where $j = 1, ..., n$ and $x_0 = x$

If desired, u_x may vary with j: this allows pixels to be selected from a wide region whilst ensuring that some of the selected pixels are close to the test pixel x_0. The value of dist (x_j , $x_{(j-1)}$) may be defined in any suitable units, such as pixel size. The definition of the neighbour group is stored in the neighbour group definition store 444.

Alternatively, a group of n pixels x_j in the neighbourhood of the test pixel x can be selected from the image store 440 , the selection being such that:

$$\mathrm{dist}(x_0 , x_{(j)}) < u_x$$

where $j = 1, ..., n$ and $x_0 = x$

As in the case of the still image, the distance function used can be any of those conventionally employed.

3. In the first embodiment of the invention the colour difference thresholds were predetermined and were not changed with each selection of a new neighbour group definition strategy. Alternatively the search strategy selected by the CPU 42 and provided to a neighbour group definition store 444 may comprise a set of colour difference thresholds (Δr_x, Δg_x, Δb_x), (or in the case of grey level images a single threshold Δt_i), as well as the neighbour group definition. Previously generated search strategies, comprising neighbour pixel groups definitions x_j and associated colour difference thresholds (Δr_x, Δg_x, Δb_x) stored in the search strategy store 445 as a result of achieving a high anomaly score on previous test pixels may be preferentially selected by the CPU 42, randomly generated candidates only being supplied by the processor 42 to the current neighbour group definition store 444 when the supply of such stored criteria is exhausted. This mechanism reduces the number of unsuccessful iterations of the process and enhances the anomaly values in the vicinity of the object of attention by reusing features that highlight mismatches in the current image.

Similarly, test groups that have achieved high anomaly scores on previous tests may be retrieved from the search strategy store 445.

As the process continues, successful search strategies (that is, combinations of values of Δr_x, Δg_x, Δb_x and u_x, and neighbour groups, which generate high values of c_x,) will become apparent. If a group of n pixels x_j and the corresponding colour difference

thresholds (Δr_x, Δg_x, Δb_x) cause the anomaly value of c_x stored in the anomaly counter 442 to reach a threshold M before a match is found, the search strategy stored in the neighbour group definition store 444 is copied to the search strategy store 445 for future use, if it is not already stored. The strategies that have generated high anomaly values are thus available in the search strategy store 445 for use in selecting suitable values in further cycles. Once a match is found, the process starts again with a new search strategy (colour difference threshold and neighbour set) stored in the neighbour group definition store 444, either by retrieval from the search strategy store 445 or generated randomly.

Initially the search strategies will be generated at random by the CPU 42, – if the strategy is not suitable for identifying differences the cycle will be rejected and a new strategy selected. Successful strategies can be stored in a search strategy store 445 for subsequent re-use.

5. Several test pixels may be processed in parallel, but for purposes of illustration only one will be considered here.

6. In the above examples, an anomaly value c_x is formed for every pixel of the array. However, in order to increase the speed of operation, the values c_x may be formed only for a subset of the pixels, for example on a regular grid such as represented by the shaded pixels in one of the layouts shown in Figure 6. Once attention values have been generated for the pixels in the subset, then further pixels in the vicinity of those having a high measure c_x may then be processed. For example one might choose the top 20% of the pixels (in terms of measures c_x) and process the pixels within a small defined area of each.

In the illustrated embodiment the pixels form a regular rectilinear tessellation, but the process is suitable for other arrangements of pixels. If the array is irregular, the positional relationship of each pixel y_j to the comparison pixel y may not be exactly the same the positional relationship of each pixel x_j to the test pixel x, but each one will be the closest possible to the exactly corresponding position.

The process possesses several advantages over other procedures. Firstly the process makes no assumptions about the content of the image and is able to extract useful features relevant to the content as part of the measurement process and hence is able to

adapt to the material in any image. Secondly the process applies equally to any configuration of pixels whether arranged in a rectangular array, a spiral array, or an irregular pattern. Thirdly the process may be applied to each pixel x_i without any dependency on the computations associated with other pixels and hence may be applied in parallel to many pixels simultaneously. This means that with a parallel implementation results may be obtained from video material in real time, or even faster. Fourthly the algorithm is based upon an evolutionary procedure which has the advantage that trials do not have to be prepared with the rigour normally afforded software processes. Some cycles may not produce useful results, for example because they contain obvious redundancy (e.g. a group of neighbour pixels x_j which includes the same pixel more than once). Such cycles are rejected in the same way as any other cycle that fails to identify distinguishing features, without any special rejection process being necessary to identify such groups. This effectively removes the computational burden required to accurately construct viable candidates for trial.

It will be noted that the process does not require any previous knowledge of the nature of the anomalies being searched for. The anomaly may be in orientation (as in Figure 3), spacing, shape, length, colour or any other characteristic.

The invention is of wide application in a number of fields. Firstly, identification of the principal subject in a visual scene is the first essential stage in the categorisation of unfiltered visual content – it is also the most difficult. Once this step has been achieved, it may be followed by manual tagging, or a range of template matching or other automatic techniques for recognition of the features so identified.

CLAIMS

1. A method of processing a moving image, for identifying areas of visual attention, comprising:

storing successive pictures of the moving image as respective arrays of picture element values;

defining a test group of picture elements comprising a first test picture element and a second test picture element having a spatial offset and a temporal offset from the first;

defining a comparison group of picture elements comprising a first comparison picture element having a spatial and temporal offset from the first test picture element and a second comparison picture element having a spatial and temporal offset from the first comparison picture element equal respectively to the spatial and temporal offset of the second test picture element from the first test picture element;

comparing the picture element values of the first and second test picture elements with the picture element values of the first and second comparison picture elements respectively, in accordance with a predetermined match criterion;

defining further such comparison groups and comparing the test picture elements with those of the further comparison groups;

generating a visual attention measure for the first test picture element in dependence on the number of comparisons made for it which the comparison results in a mismatch.

2. A method according to Claim 1 including: defining at least one further comparison group comprising a first further comparison element having the same spatial offset from the first test picture element as has the first comparison picture element, but a different temporal offset, and a second further comparison picture element having the

same offset from the first further comparison picture element as the second test picture element has from the first test picture element, and the comparing step includes comparing values of the first and second further comparison picture elements with the values of the first and second test picture elements respectively.

3. A method according to Claim 1 or 2 in which the test group and the or each comparison group includes at least one additional picture element.

4. A method according to Claim 1, 2 or 3 comprising defining a subset of said pixel array and generating said measure of visual attention in respect of test pixels in said subset.

5. A method according to Claim 4, comprising the further steps of identifying one or more of said test pixels for which said measure is indicative of a large number of mismatches relative to the measures generated for others of said test pixels and generating said measures for further test pixels in the vicinity of said one or more identified test pixels.

6. A method according to any one of the preceding claims wherein, for each test pixel, if the comparison results in a match, a new offset for the second test picture element is chosen.

7. A method according to any one of the preceding claims, wherein a plurality of test picture elements are analysed concurrently.

8. A method according to any one of the preceding claims, wherein the value is a three-element vector representative of a colour.

9. A method according to any one of the preceding claims wherein in addition to neighbour groups, further variable search parameters are selected.

10. A method according to claim 6, wherein the further variable search parameters include a threshold value for the determination of whether two picture element values are substantially similar.

11. A method according to any one of the preceding claims including the further step of

(a) identifying ones of said positional relationships which give rise to a number of consecutive mismatches which exceeds a threshold;

(b) storing a definition of each such identified relationship; and

(c) utilising the stored definitions for the processing of further test pixels.

12. A method of processing a sequence of visual images, for identifying areas of visual attention, comprising the steps of:

storing a sequence of images as a multi dimensional array of pixels, each pixel having a value;

selecting test pixels from the array,

for each test pixel, selecting one or more neighbour groups of pixels neighbouring the test pixel;

selecting comparison pixels from the array;

identifying a group of pixels neighbouring a selected comparison pixel having the same respective positional relationships to the comparison pixel as a selected neighbour group of pixels has to the test pixel;

comparing the values of the selected neighbour group with the values of the identified group in accordance with a predetermined match criterion,

generating a measure of visual attention for each test pixel, in dependence upon the number of comparisons made for that test pixel for which the comparison results in a mismatch.

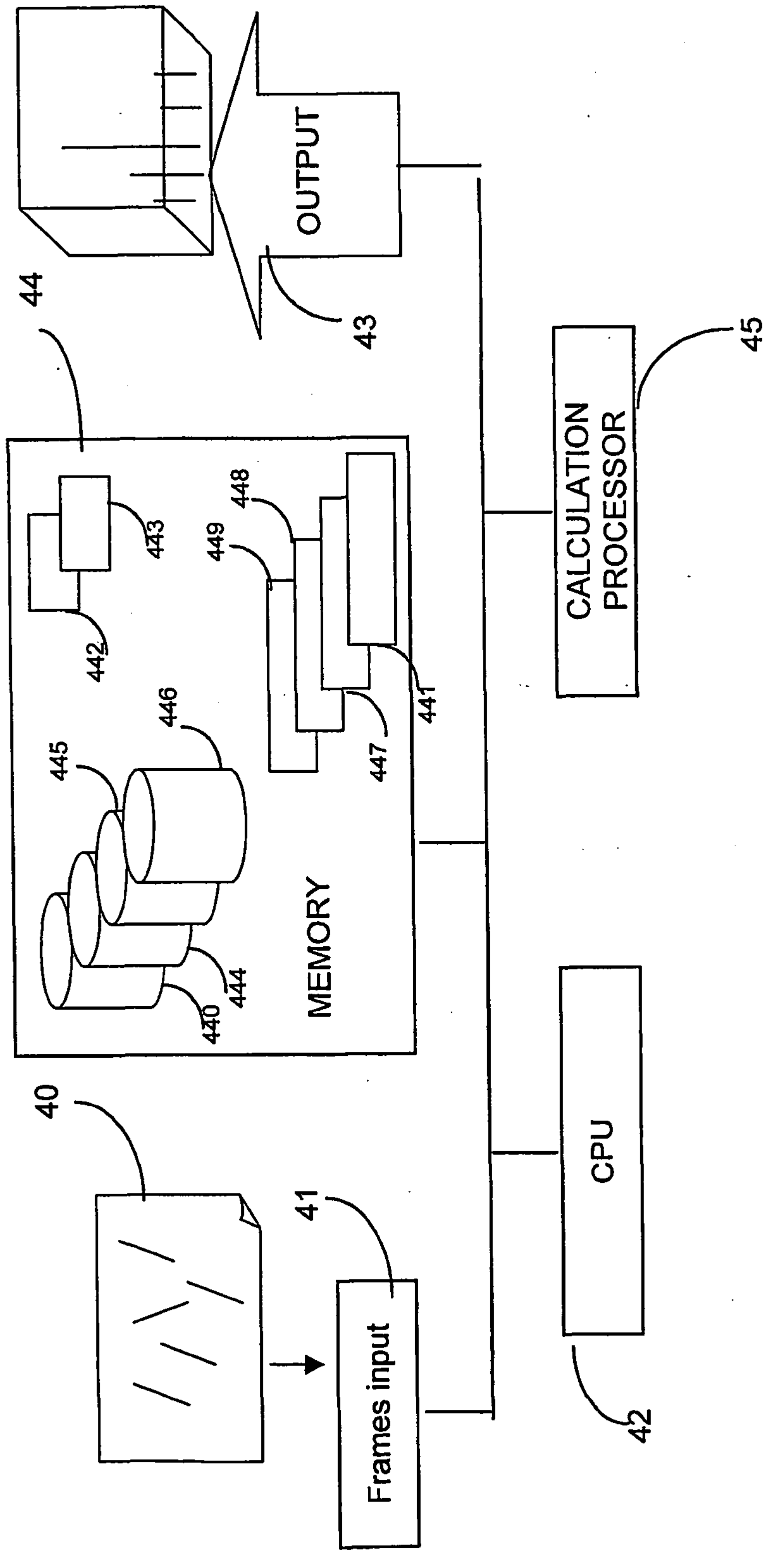
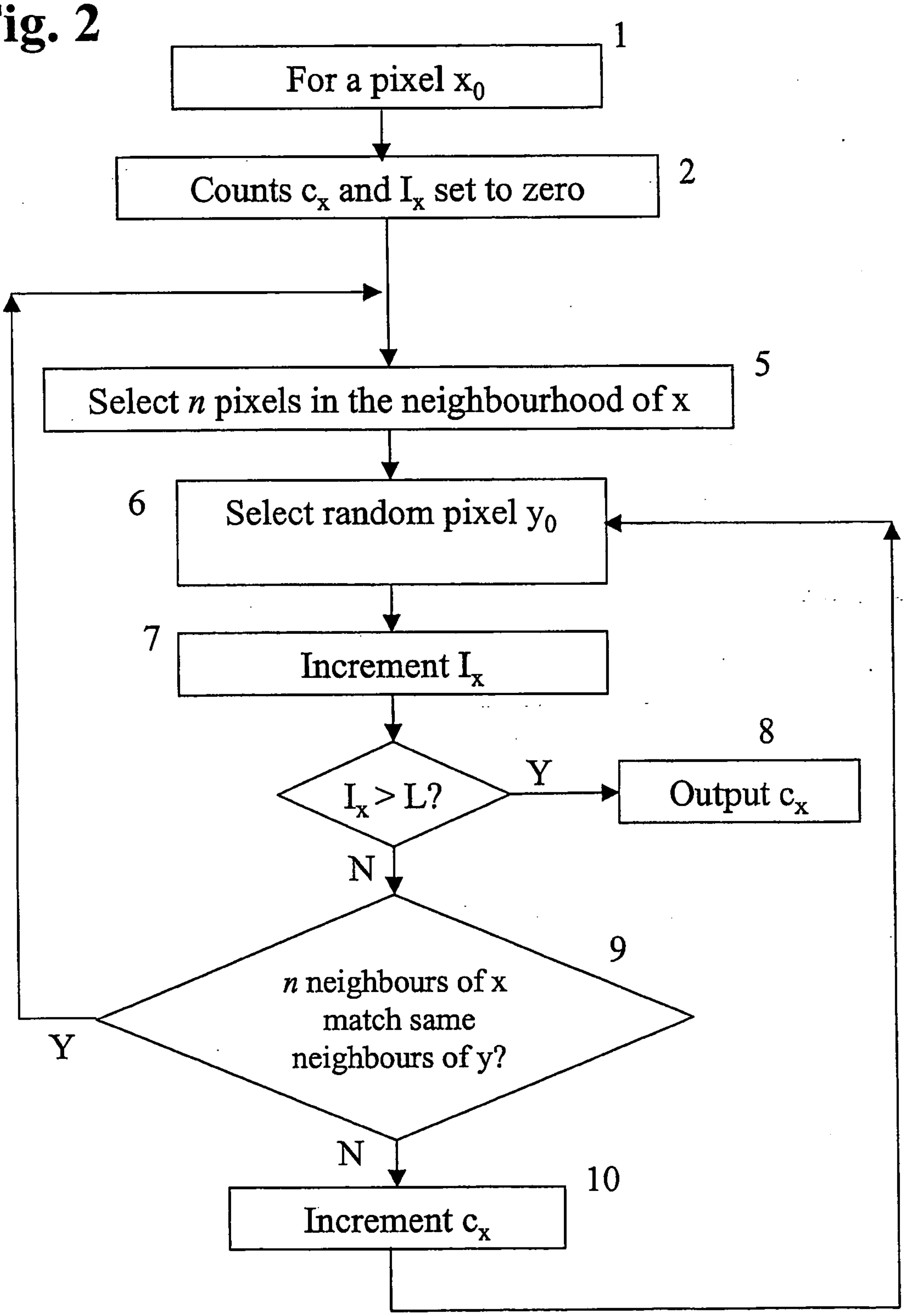

OUTPUT
43
44
MEMORY
443
442
448
449
441
447
446
445
444
440
CALCULATION PROCESSOR
45
40
41
Frames input
CPU
42

Fig. 1

Fig. 2


1
For a pixel x_0
2
Counts c_x and I_x set to zero
5
Select *n* pixels in the neighbourhood of x
6
Select random pixel y_0
7
Increment I_x
$I_x > L$?
Y
8
Output c_x
N
9
n neighbours of x match same neighbours of y?
Y
N
10
Increment c_x

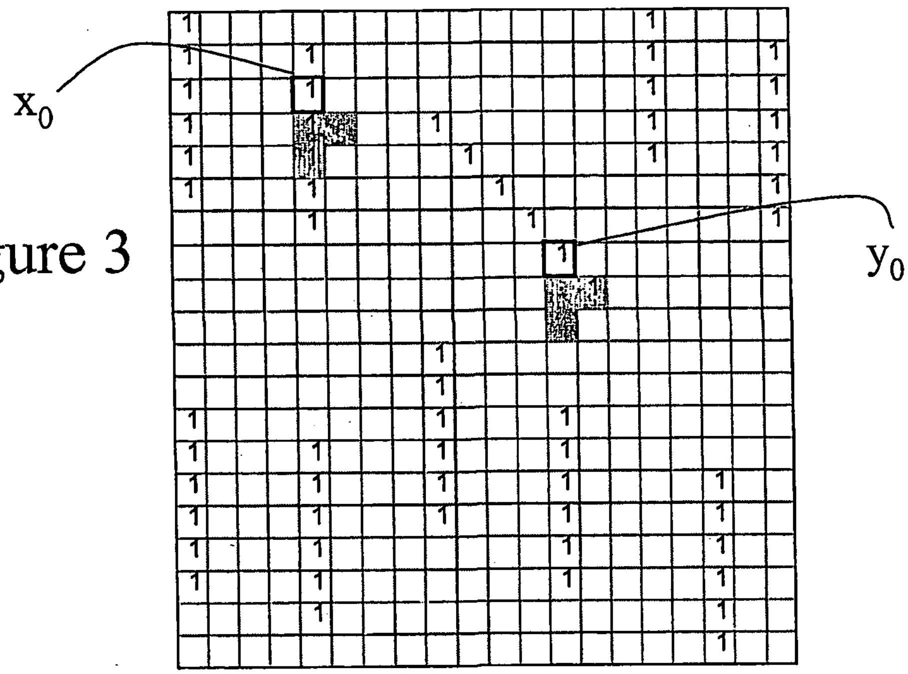


Figure 3

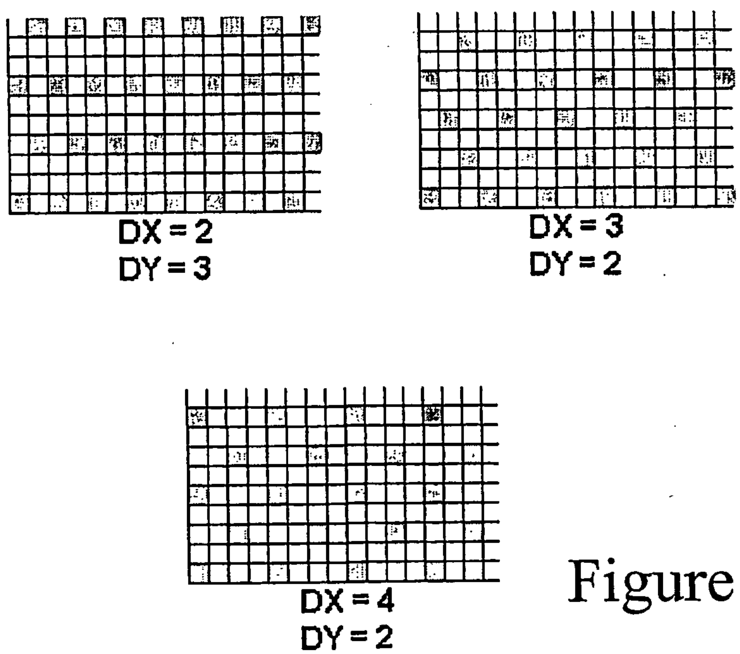
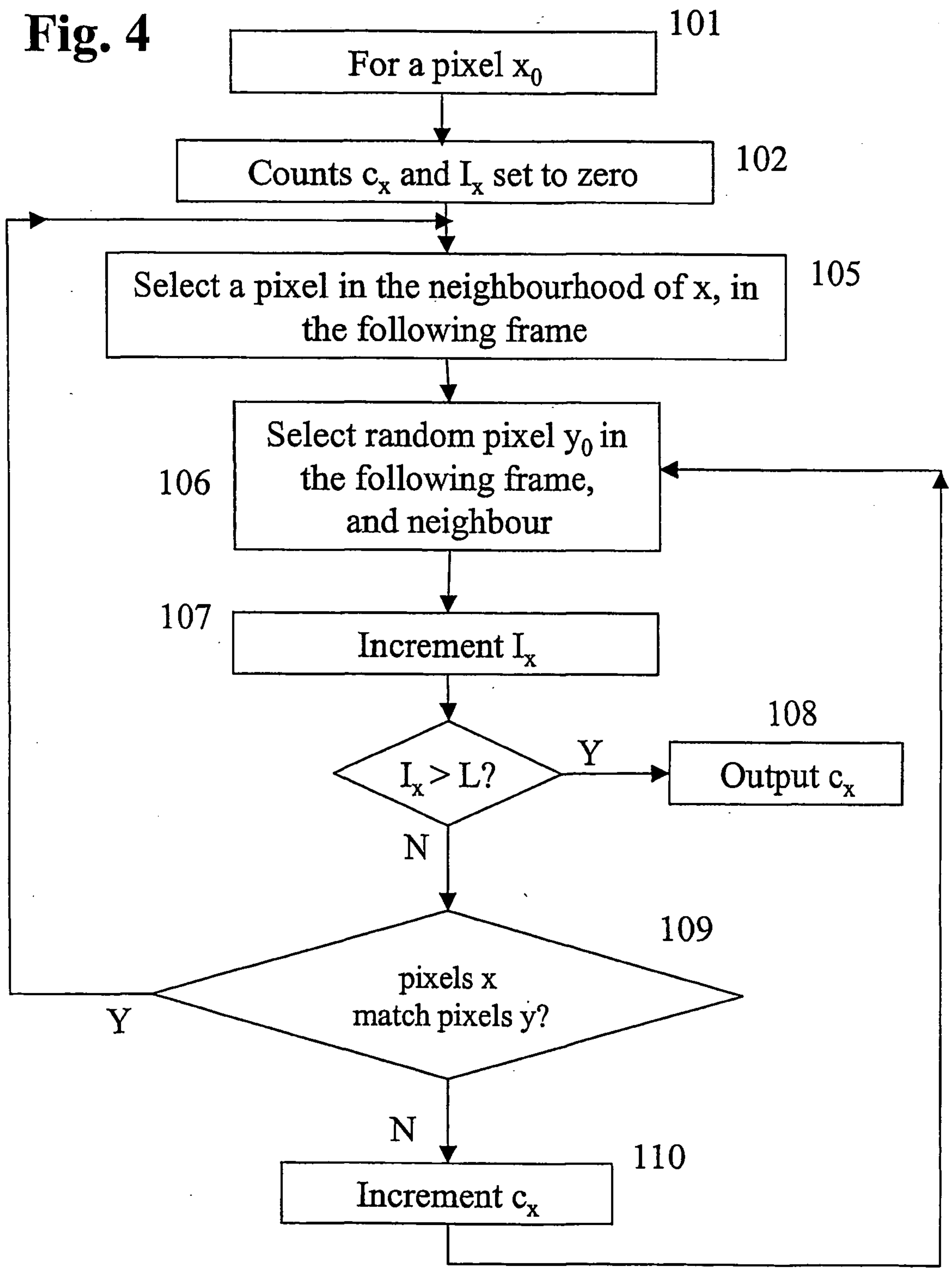


Figure 6

Fig. 4


101
For a pixel x_0
102
Counts c_x and I_x set to zero
105
Select a pixel in the neighbourhood of x, in the following frame
106
Select random pixel y_0 in the following frame, and neighbour
107
Increment I_x
$I_x > L$?
Y
108
Output c_x
N
109
pixels x match pixels y?
Y
N
110
Increment c_x

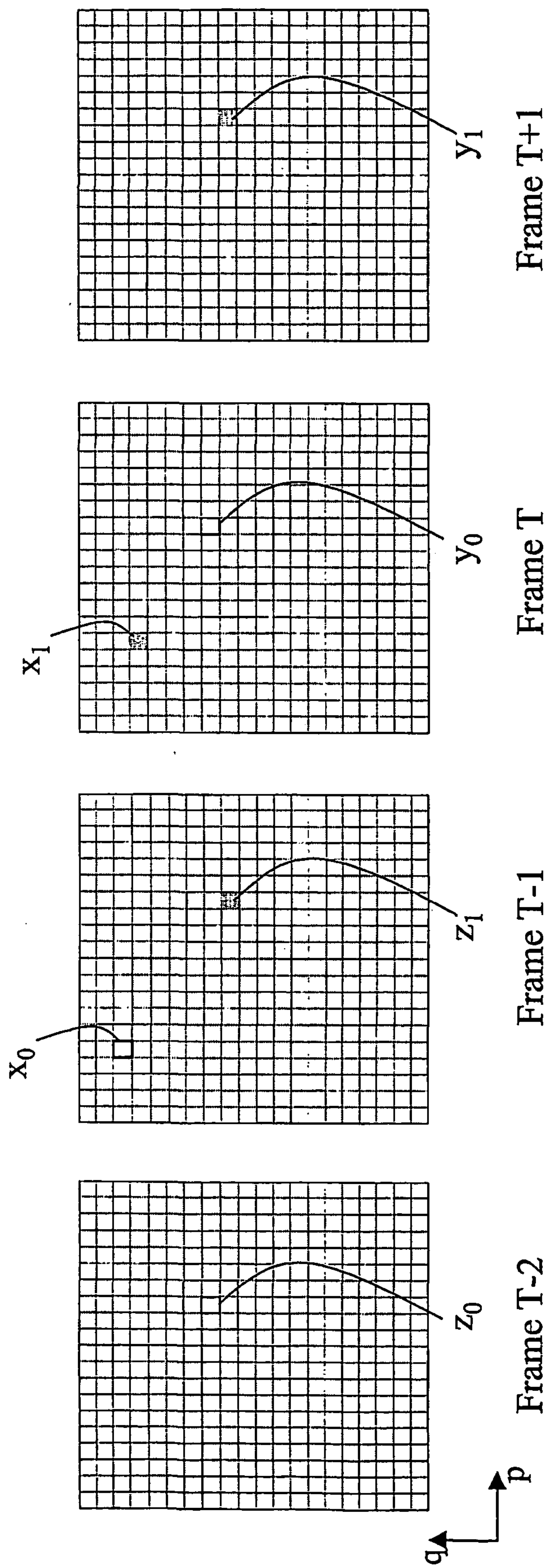


Fig. 5

INTERNATIONAL SEARCH REPORT

Inte   ıal Application No
PCT/GB 01/03802

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G06T7/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G06T

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, INSPEC, IBM-TDB

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WIXSON L: "DETECTING SALIENT MOTION BY ACCUMULATING DIRECTIONALLY-CONSISTENT FLOW" IEEE TRANSACTIONS ON PATTERN ANALYSIS AND MACHINE INTELLIGENCE, IEEE INC. NEW YORK, US, vol. 22, no. 8, August 2000 (2000-08), pages 774-780, XP000976485 ISSN: 0162-8828 page 778, right-hand column, paragraph 5 -page 779, left-hand column, paragraph 6 page 775, right-hand column, paragraph 3.1 -page 776, right-hand column, paragraph 3.2 -----	1,12

☐ Further documents are listed in the continuation of box C.

☐ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
5 December 2001	13/12/2001

Name and mailing address of the ISA	Authorized officer
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